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Changes in the Blood Picture in Pregnancy, Delivery, and Puerperium, Particularly Centering Around the Blood Loss During Delivery

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Changes in the Blood Picture in Pregnancy, Delivery, and Puerperium, Particularly Centering Around the Blood Loss During Delivery*

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Abstract

For the periods ranging from the fifth gravid month to the sixth post partum week continuous examinations were conducted on the blood picture of 10 multiparas and 18 primiparas who came to the Second Maternity Hospita, Okayama University Medical School, from December 1955 to December 1956, and all those who had no complications throughout pregnancy, delivery and puerperium. In addition observations were carried on the 245 subjects who had no complibation throught pregnancy, delivery and puerperium to see what influences the blood loss during delivery might exert on blood picture during puerperium, particularly the changes of hemoglobin concentration (Hb), and the author arrived at the following conclusions: 1) By the continuous examinations of pregnat women the existence has been recognized of physiological anemia which recovers close to the level of healthy non-pregnant women within one month after delivery. Namely, it has been found that already by the fifth month of pregnancy a considerable decrease both in erythrocyte counts and Hb values is recognized as compared with those of healthy non-pregnant women (the control), but starting around the eighth month the values of both keep on increasing month after month until reaching their maximum at delivery yet still a little below those of the control, and particularly Hb values as compared with those of the control show a significant fall. During puerperium erythrocyte counts and Hb values recover rapidly and by the sixth post partum week they reach close to the level of the control. 2) By the latter part of pregnancy both in multipara and primipara Hb values shew a marked decrease as compared with erythroyte count. Gradually presenting hypochromic-anemia picture, even in the sixth post partum week a delay in the recovery of Hb values can still be recognized, the delay being particularly striking in primipara. 3) It has been noticed that there is a greater tendency of delay in the recovery of Hb values along with increase in blood loss during delivery. Namely, though in the groups with blood loss of less than 10g./kg. at delivery the recovery of Hb values during puerperium is smooth and hematopoietic functions seem to be undisturbed. However, with increase in blood loss the recovery is proportionately delayed and in the groups with over 12.5 g./kg. loss a marked delay in the recovery of Hb has been recognized. 4) In primipara groups with under 7.5g./kg. blood loss and in multipara with under 12.5 g./kg. loss, the recovery of Hb values during puerperium is smooth; but in primipara

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with blood loss of over 10 g./kg. and in multipara with the loss of over 15 g./kg. the delay has been quite marked. In other words, in the groups with blood loss of over 7.5 g./kg. the rate of recovery in Hb values tends to be faster in multipara than in primipara. 5) Along with increase in the frequency of labor, the rates of increase have tended to increase by degrees.

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**CHANGES IN THE BLOOD PICTURE IN PREGNANCY,
DELIVERY AND PUERPERIUM (PARTICULARLY
CENTERING AROUND THE BLOOD LOSS
DURING DELIVERY)**

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INTRODUCTION

Ever since NASSE³⁶ in 1876 first made a report on the anemia of pregnancy, there appeared many studies on the blood picture of pregnancy, delivery and puerperium, indeed too numerous to count. Likewise ever after 1911 when DIETRICH²⁹ called attention to the necessity of continuous examinations throughout the periods of pregnancy, delivery, and puerperium, a considerable number of reports on the same subject have been presented by many investigators but their results are by no means in agreement with one another. As for the factors controlling the blood picture of puerperium, the factors such as blood loss during delivery, lochia rubra, lactation, state of recuperation of the genital organ, hematopoietic functions and water metabolism may be mentioned. As reported by NOSE¹², TAKANASHI²⁰, NAKANISHI¹³, and ALBERS²⁴, it is generally conceded that the greater the blood loss during delivery the slower is the recovery of blood picture, but nonetheless there is as yet no comprehensive report dealing with the blood loss during delivery, which affects shift of the blood picture in puerperium.

By elucidating the shift of blood picture throughout the periods of pregnancy, delivery and puerperium with uninterrupted examinations, and by measuring accurately the amounts of blood loss during delivery, the author has carried out series of observations on the influences of amounts of blood loss during delivery to be exerted upon the shift in the blood picture of puerperium. The following are the report on these findings.

ON THE SHIFT OF BLOOD PICTURE IN PREGNANCY,
DELIVERY, AND PUERPERIUM.

1. SUBJECTS AND METHODS.

Subjects : The subjects of the present study were 10 multipara and 18 primipara, who gave birth to matured new-born child by spontaneous delivery at term in the second Maternity Hospital of Okayama University Medical School during the period of December 1955 to Dec. 1956 and all those had no complication during the pregnancy and whose blood loss during delivery was less than 500 g. Moreover, none of them received painless delivery nor blood making medicine. As for the control 16 healthy non-pregnant women were selected.

Method : Erythrocyte counts and hemoglobin concentration were measured once a month from the periods ranging 5th to 9th month of pregnancy, and at the 10th month they were measured at the initial, intermediate, and last phase ; and thereafter, at delivery, immediately after delivery, on the first post partum, 3rd, 5th, 6th post partum days, and in the sixth post partum week. However, at delivery they were measured at the time of crowning of the head and immediately after delivery, two hours after the expulsion of placenta. Blood was drawn from the pinna while keeping the subject perfectly quiet at the same time.

Erythrocyte count was taken with Bürker-Türk's blood counting chamber by multiplying ten thousand times the total number of erythrocytes in 80 small squares. As for the hemoglobin concentration the Erma standard hemometer (100 % = 16 g./dl.) was used and by warming blood in hot water bath at the temperature of 30°C—60°C for 15 minutes it was measured by the sun-light at the north side window. In this the same hemometer was used for the same subject and all possible cares were taken to keep the error at minimum. All the Bürker-Türk counting chambers and Erma standard hemometers were the one inspected and certified by Japan Hematological Society. Color index was determined by the equation,
$$\frac{\text{hemoglobin concentration (\%)}}{\text{erythrocyte count (100,000 units} \times 2)} = \text{color index.}$$
 Blood loss during delivery was calculated by measuring the blood loss during the periods from delivery of new-born child to 2 hours after the expulsion of placenta by weight method, exempting erroneous ones. As for the control, erythrocyte counts and Hb value of 16 healthy non-pregnant women were measured at mid-way between menstruations and their average was taken as the basis. Stochastic determination was done all at the margin of error of 5 per cent.

2. RESULTS.

Values of healthy subjects : Erythrocyte counts, Hb values and color index of 16 healthy non-pregnant women (average age, 22 years) were found to be as follows : If confidence intervals is calculated by the average of measured values and reliability at 95 per cent, they become :

erythrocyte count mean 4,555,600 ($4,888,600 \geq m \geq 4,222,600$)

maximum 4,960,000 minimum 4,000,000

hemoglobin concentration mean 88.96 % ($96.20 \geq m \geq 81.72$)

Maximum 104 % minimum 76 %

color index mean 0.980 ($1.022 \geq m \geq 0.938$)

maximum 1.16 minimum 0.86

Blood picture in pregnancy, delivery, and puerperium: Results of 18 primipara and 10 multipara are shown in Tables 1 and 2, and their curves in Figs. 1 and 2.

Table 1 Normal Primipara

preg. mos.	healthy non- preg. nant w.	V	VI	VII	VIII	IX	X		
							begin.	mid.	end
cases	16	18	18	18	18	18	14	12	10
Rote (unit 10, 000)	455.5	355.5	360.8	361.3	383.4	393.1	402	420	440
	±33.3	±14.62	±12.58	±48.68	±20.03	±20.77	±21.2	±35.1	±32.6
Hb (%)	88.96	77.80	74.77	73.91	75.25	76.55	77.7	79.2	82.2
	±7.24	±3.11	±2.93	±3.58	±3.23	±3.95	±5.64	±5.67	±6.44
color index	0.98	1.09	1.04	1.02	0.98	0.97	0.96	0.94	0.94
	±0.042	±0.080	±0.053	±0.074	±0.073	±0.076	±0.11	±0.10	±0.09

\pm reliability limit

p. p. = post partum

at deliv.	immed. after del.	1st p. p. day	3rd p. p. day	5th p. p. day	6th p. p. day	6th p. p. week
18	18	18	18	18	18	18
439.1	417.2	411.9	424.1	435.1	444.2	491.8
± 30.44	± 15.46	± 28.84	± 21.68	± 15.25	± 25.40	± 35.13
82.30	81.41	81.97	80.97	83.30	84.66	87.80
± 3.16	± 4.04	± 4.39	± 3.19	± 3.71	± 3.43	± 4.51
0.94	0.97	1.00	0.96	0.97	0.96	0.90
± 0.050	± 0.075	± 0.058	± 0.063	± 0.006	± 0.073	± 0.045

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Table 2 Normal Multipara

preg. mos.	healthy non-preg. women	V	VI	VII	VIII	IX	X		
							begin.	mid.	end
cases	16	10	10	10	10	10	8	10	7
Rote (unit 10,000)	455.5	374.8	368.0	357.2	369.0	378.0	405	417	418
	± 33.3	± 38.33	± 37.95	± 38.39	± 33.79	± 35.82	± 38.2	± 38.3	± 48.8
Hb (%)	88.96	79.35	79.45	77.95	76.40	78.45	81.5	80.0	81.3
	± 7.24	± 4.31	± 4.29	± 4.43	± 6.79	± 8.18	± 7.0	± 7.6	± 12.8
color index	0.98	1.07	1.09	1.10	1.04	1.04	1.01	0.95	0.97
	± 0.042	± 0.082	± 0.107	± 0.092	± 0.079	± 0.094	± 0.05	± 0.12	± 0.12

p. p. = post partum \pm reliability limit

at deliv.	immed. after deliv.	1st p. p. day	3rd p. p. day	5th p. p. day	6th p. p. day	6th p. p. week
10	10	10	10	10	10	10
423.2	396.6	395.3	396.5	418.6	437.1	478.8
± 41.74	± 55.98	± 33.80	± 26.27	± 53.31	± 61.78	± 60.52
82.15	79.45	81.60	82.65	84.75	87.25	90.90
± 6.08	± 8.22	± 5.14	± 6.00	± 8.91	± 9.70	± 8.61
0.98	1.01	1.04	1.05	1.03	1.01	0.95
± 0.045	± 0.132	± 0.065	± 0.028	± 0.072	± 0.111	± 0.116

Fig. 1. Primipara

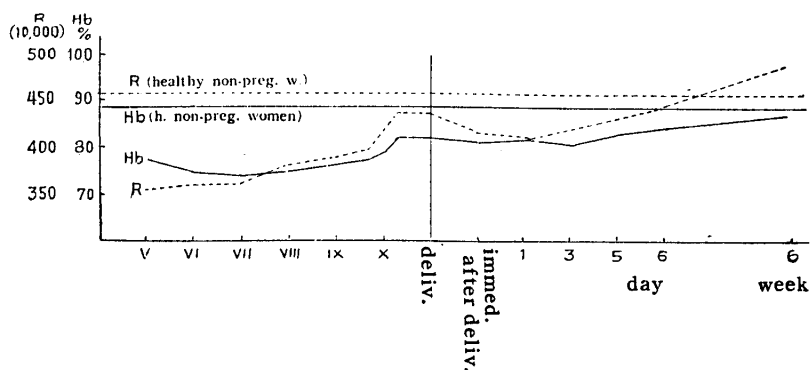
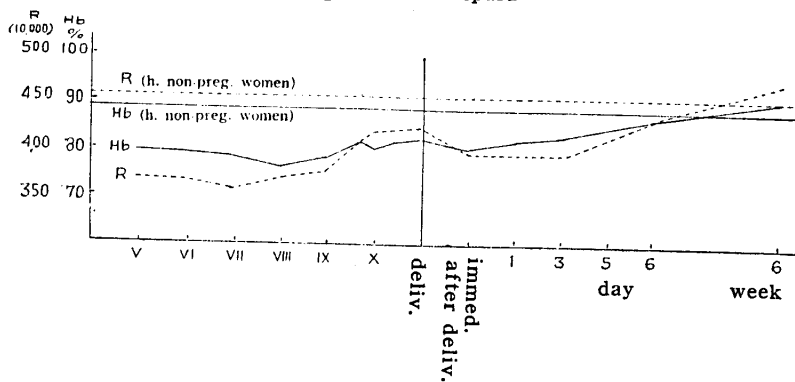


Fig. 2. Multipara



1) Changes of erythrocyte count.

i) Primipara: As compared to the erythrocyte counts of healthy non-pregnant women in the fifth month of pregnancy the count already shows a marked decrease; and thereafter showing no marked change up to the 7th month, it increases rather rapidly from the 8th month, reaching the maximum at delivery. Viewing stochastically although the count shows significant differences from the 5th to 9th month of pregnancy as compared with that of the control, on the 10th month of pregnancy and at the delivery it shows no significant difference. Immediately after delivery it is a little lower than that at delivery, and reaching minimum on the first post partum day, and recovering gradually thereafter, on the 6th post partum day it returns close to that of delivery. Later on the 6th post partum week it is increased still further, the average being around 4,910,000 exceeding that of healthy non-pregnant women. Erythrocyte counts both on the 6th post partum day and on the sixth post partum week show no significant change as compared with those of the control.

ii) Multipara: On the 5th month of pregnancy multipara already shows a significant decrease in the erythrocyte count as compared with the healthy control and reaching the minimum on the 7th month, it gradually tends to increase thereafter, reaching the maximum at delivery. During the periods from the 5th month to the 9th month the counts are significantly lower than respective values of the control. Though the counts at the 10th month and at delivery have not recovered to those of the control, stochastically they show no significant difference. The value at delivery as compared with that on the 7th month of pregnancy shows a significant increase but comparing it with that at the latter part of the 10th month no significant increase can be seen. Immediately after delivery it is a little lower than that at delivery and reaching minimum on

the first post partum day, and gradually increasing later, on the 6th post partum day it shows the value a little higher than that at delivery but has not returned to the level of the healthy control. In the 6th post partum week the average count is 4,770,000 showing the increase exceeding the value of healthy non-pregnant women. Judging the counts on the 6th post partum day and in the 6th post partum week stochastically no significant difference can be discerned as compared with respective values of the control.

2) Changes in hemoglobin concentration.

i) Primipara : Hemoglobin concentration in primipara on the 5th month of pregnancy is already markedly decreased as compared to that of the control, and in the 7th month it is at its minimum ; and there-after increasing gradually it reaches its maximum at delivery. Immediately after delivery it is somewhat lower than at delivery and on the 3rd post partum day it again reaches its minimum; and later increasing gradually on the 6th post partum day it is somewhat higher than at delivery. On the 6th post partum week it returns more or less to the level of that of the control but its recovery is not so high as the recovery of erythrocyte count. Viewing it stochastically the values of Hb during the period from the 5th month of pregnancy to delivery are all significantly lower as compared with those of the control during the respective period but the values on the 6th post partum week differ not significantly when compared with respective values of the control. Moreover, the value of Hb at delivery is significantly higher than those in the 7th and the 10th months, but when it is compared with that of the control there is a decrease of about 7.4 percent.

ii) Multipara : In the 5th month the value of Hb shows a marked decrease as compared to that of control, which reaches its minimum in the 8th month of pregnancy. Later it tends to increase gradually and in the 10th month it reaches its maximum but a delivery, though it gradually increases, it shows no significant difference as compared with that at the last stage of the 10th month of pregnancy. The value immediately after delivery is a little lower than that at delivery, but later increasing by steps on the 6th post partum day it shows a higher value than that at delivery and is about at the same level as that of the healthy non-pregnant women. Later in the 6th post partum week it recovers to 90 per cent, exceeding that of the control. Judging stochastically all the values of Hb during the periods from the 5th month of pregnancy to delivery are significantly lower than those of the control but the values on the 6th post partum day and in the 6th post partum week as compared with respective values of the control show no significant difference. Moreover, the value

of Hb at delivery shows a significant increase as compared to that of the control, it shows a decrease of about 7.6 per cent.

3) Change of Color Index.

i) Changes during pregnancy : Color index of primipara up to the 7th month of pregnancy and that of multipara up to the 9th month tend to be over 1, but in primipara after the 8th month of pregnancy and in multipara after the 10th month to delivery time a decrease in their indices can be recognized; and in the latter stage of pregnancy the increase of Hb values does not match the rate of increase in the erythrocyte counts. The color index in primipara has a tendency to decrease earlier than that in multipara.

ii) Changes in puerperium : In primipara color index in the early stage of puerperium shows no marked difference from that at delivery but in the sixth post partum week it is lower than that on the 6th post partum day ; and the recovery of hemoglobin is not so complete as that of erythrocyte count. In multipara color index at the early stage of puerperium has a tendency to increase but in the 6th post partum week it is lower than that at delivery ; and the recovery of hemoglobin is not so complete as the increase of erythrocyte count.

3. SUMMARY AND DISCUSSION

Since NASSE's³⁶ report (1876) on the incidence of anemia in pregnant women, many reports on the blood picture of pregnant women have been made by various investigators. There are those who claim that almost no change occurs in erythrocyte count, hemoglobin concentration and hematocrit value during pregnancy, while some contend that these values increase, and still others maintain the view that these decrease during pregnancy. The reason that the results of studies on the blood picture in pregnant women by various scholars do not coincide with each other seems to be in the fact that the blood picture of pregnant women is variable and its individual difference is so great. That no standardized instruments are used in the examinations of pregnant women and that in the majority of these studies the same individual is not being examined continuously all through the stages of pregnancy, delivery and puerperium seems to be another reason for such a discrepancy. DIETRICH²⁹ attaches an especial importance to the continuous examinations of pregnant women. With a view to keep error at minimum the author paid a special attention to the method and apparatuses of examinations. It is said that physiological anemia in pregnancy occurs due to anemia induced by cellular dilution

resulting from an increase in plasma volume. SUZUKI¹⁵, KAWAGATA⁶, KAWADA⁵, NAGAMURA¹⁰, TANAKA¹⁷, DIECKMANN²⁸, ALBERS²⁴ and THOMPSON⁴⁵ state that increases in the plasma and the cellular volumes are mainly responsible for the increase in total volume of circulating blood occurring in pregnancy but the changes of the two are not of the same degree, and that since the increase in the cellular volume is far less than that in the plasma volume, the circulating blood is in the diluted state. It is said that in addition to this phenomenon of cellular dilution the lowering of hematopoietic functions, destruction of blood corpuscles, or a decrease in the stored iron content is also responsible for the occurrence of anemia in pregnancy. KOGA⁷ and SUZUKI¹⁵ report that up to the 8th month of pregnancy the dilution of blood corpuscles in blood and by the 10th month mainly a decrease in plasma volume (water content in blood) can be recognized with resultant cellular concentration. In the present experiment likewise both in primipara and multipara erythrocyte counts and hemoglobin concentration in the 5th month of pregnancy are already markedly decreased as compared with those of the control and these values, reaching their minimum in the 7 — 8th month and later gradually increasing, reach their maximum in the 10th month of pregnancy, thus delivery follows; and these results coincide more or less with those of various investigators.

Concerning the changes occurring at delivery, NAKAYAMA¹¹, and YOSHIMATSU-OKADA²² mention that blood becomes concentrated due to the labor at delivery, ALBERS²⁴ states that blood at delivery becomes concentrated by penetration of water from blood vessels into tissues as the result of a rise in venous pressure caused by labor pains. ISHIKAWA³, SUZUKI¹⁵, NAGAMURA¹⁰, NAKAYAMA-ARAKI¹¹, HATA², PAYER³⁸, DUBNER³⁰, and DIETRICH²⁹ all claim that erythrocyte count and Hb value increase at delivery, TSUTSUI¹⁸ and FUKUDA¹ report these increases at delivery are especially striking in primipara while in multipara these increases are hardly noticeable. MUKAI⁹ states these values at delivery show no marked difference from those in the latter stage of pregnancy. In the present experiment erythrocyte count and hemoglobin value at delivery presented a slight increase over those in the latter stage of pregnancy both in primipara and multipara, but similar to the report by MUKAI⁹ no marked change could be recognized. Relative to the changes in circulating blood volume after delivery SUZUKI¹⁵, KAWAGATA⁶, ALBERS²⁴, CATON²⁶, DIECKMANN²⁸, and STRAUSS⁴² report that in puerperium circulating blood volume decreases further and it reaches normal level around the second post partum week and that such a decrease is due mainly to the

decrease in plasma volume rather than the decrease in cellular volume. Viewing results concerning fluctuations of erythrocyte counts and Hb values in puerperium in the cases of normal loss of blood at delivery reported by various investigators, NAGAMURA¹⁰ and SUZUKI¹⁵ say that the values do not reach to non-pregnant values on the 4 — 7th post partum days; HATA² and TATÉ¹⁹ claim recovery to the values before delivery is not seen by the 7th post partum day; TSUTSUI¹⁸, MUKAI⁹, NAKAYAMA-ARAKI¹¹, DIETRICH²⁹, DUBNER³⁰, and OGATA³⁷ report the values return to those of the latter part of pregnancy on the 5 — 8th post partum days; FUKUDA¹ claims that Hb values in primipara return to the normal values and erythrocyte count exceeds the normal value by the 5th post partum day, and that in multipara both erythrocyte count and Hb value do not return to the normal by the 5th post partum day: ISHIKAWA³ says hemoglobin value returns to that of the initial stage of pregnancy by the 7th post partum day; YASUI²³ mentions that in both primipara and multipara Hb values by the 7th post partum day are normal but they do not yet reach those during delivery and that the degree of changes in multipara is less and erythrocyte count on the 7th post partum day can not recover to the normal and it has not yet then reached to that during delivery; NOSÉ¹² says in earlier cases the Hb values start recovering after the 5th post partum day while in some of slower cases the Hb values do not recover even with lapse of 15 days after delivery; TAKANASHI²⁰ reports that Hb values and erythrocyte counts are within normal range on the 7th post partum day but the degree of recovery is not yet complete.

As is evident, these results do not at all agree with each other; in the author's experiment, however, the values in pregnancy and at delivery were lower than those of the healthy non-pregnant women, and erythrocyte counts and hemoglobin values started to recover rapidly after delivery, and on the 6th post partum day these values both in primipara and multipara, though not quite up to the normal, exceeded those at delivery; and by the 6th post partum week erythrocyte counts and Hb values both in primipara and multipara recovered to the normal or some even passed beyond the normal values. Comparing the rates of increases in erythrocyte count and Hb value, TERHOLA⁴⁴, DIETRICH²⁹, DIECKMANN²⁸, and KÜHNEL³⁴ report that the recovery of erythrocyte counts is faster than that of the Hb values; and in the present experiment the rate of erythrocyte-count recovery was much more rapid than that of the Hb value.

FUKUDA¹, KAWAGATA⁶, GALLOWY³¹, LYON³⁵, HARVEY³², and DIECKMANN²⁸, recognize an increase in the hemoglobin index during pregnancy, especially in the first half and SUZUKI¹⁵, reports that hemoglobin index

falls during pregnancy. In the author's experiment up to the middle period of pregnancy both primipara and multipara presented hyperchromic state, and the majority of multipara presented a higher value than primipara even during the latter half of pregnancy. These results more or less coincide with the results of FUKUDA¹, KAWAGATA⁶, HARVEY³², GALLOWY³¹, and LYON³⁵; but in the latter part of pregnancy the lowering of color index was observed as reported by SUZUKI¹⁵, Pohl u BERGMANN³⁹, RICHTER⁴⁰, and KÜHNEL³⁴. In the majority of cases a transient rise in the values could be observed immediately after delivery and during the early part of puerperium no marked change was observable and the values remained more or less within the normal range as reported by DIECKMANN²⁸; and thereafter in the 6th post partum week the lowering of color index was recognized as reported by KAWAGATA⁶, SUZUKI¹⁵, KÜHNEL³⁴, and DIECKMANN²⁸. The reason for the gradual lowering of color index in the latter part of pregnancy and in puerperium seems to lie in the fact that despite the vigorousness of hematopoietic functions as well as active production of new erythrocytes in the latter part of pregnancy iron supply to these newly produced erythrocytes can not meet the requirement sufficiently fast enough, thus resulting in a gradual fall in the color index. It is worthy of notice that this phenomena appear in the latter part of pregnancy and in puerperium even in normal pregnant women as well as in the cases where there was no great loss of blood during delivery, and especially markedly in primipara. KÜHNEL³⁴ reports that it requires as long as almost half a year after delivery for erythrocytes, hemoglobin, and hemoglobin index to return completely to normal.

ON THE FLUCTUATIONS OF BLOOD PICTURE IN PUERPERIUM (centering around blood loss during delivery)

1. SUBJECTS AND EXPERIMENTAL METHOD.

Erythrocyte counts and Hb values were measured in 384 subjects who had given birth to a child at the Second Maternity Hospital, Okayama University Medical School, excepting those receiving blood transfusion, painless delivery or haemataca. The respective measurements were taken at delivery, immediately after delivery, on the 6th postpartum day, and in the sixth post partum week. By the method described in the previous part, blood loss during delivery, Hb values, and erythrocyte counts were measured, all individuals being measured continuously. Further, the blood loss during delivery is represented in blood loss (g.) per kilogram of body weight (weight at admission), and stochastic estima-

tions are all done with 5 per cent margin of error. As for the rates of increase or decrease in erythrocyte counts and Hb values they are represented either as (+) or (-) taking the value at delivery as the basis.

2. RESULTS.

Of the 384 cases, excluding those whose duration of pregnancy was less than 266 days, whose hemoglobin value was under 60 per cent, whose length of labor lasted over 30 hours, those giving birth to a child weighing over 4,000 g. or under 2,500 g. as well as those who had complication such as toxemia of pregnancy or puerperal fever, those on whom obste-

Table 3 Observations on Individual Differences in Blood Loss (Hb %)

(observations up to the 6th p. p. day)									
blood loss (g./kg)	0~2.5 g	2.5~5.0	5.0~7.5	7.5~10	10~12.5	12.5~15	15~17.5	17.5~20	over 20 g
cases	8	46	63	45	26	26	9	10	12
at deliv.	79.8	82.3	82.7	79.8	81.9	82.8	83.0	83.7	82.6
immed. after deliv.	84.1 (+5.66)	81.4 (-1.07)	80.9 (-1.94)	76.8 (-3.54)	77.9 (-4.70)	78.1 (-5.59)	77.7 (-6.04)	76.9 (-8.17)	76.3 (-7.63)
on the 6th p. p. day	88.1 (+10.76)	86.0 (+4.62)	86.2 (+4.61)	81.7 (+2.68)	81.9 (-0.73)	78.4 (-5.09)	75.5 (-8.53)	74.4 (-10.01)	68.1 (-17.29)
6th p. p. week									

() increase or decrease %

(up to the 6th p. p. week)					
0~5 g	5~7.5	7.5~10	10~15	15~20	over 20 g
30	28	23	33	12	9
82.6	82.3	78.3	81.5	80.9	86.3
83.4	81.0	75.0	77.1	76.5	80.2
(+1.15)	(-1.26)	(-3.96)	(-5.21)	(-5.05)	(-4.04)
87.3	85.0	79.4	76.7	73.5	70.0
(+6.16)	(+3.55)	(+1.45)	(-5.86)	(-7.88)	(-18.97)
89.1	89.6	82.3	82.5	83.6	80.0
(+9.10)	(+8.99)	(+5.90)	(+2.18)	(+3.46)	(-6.88)

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Table 4 Hb Values on the Sixth Post Partum Day (collective case)
(unchanged.....± changes less than 5%)

blood loss (g./kg)	0~2.5 g		2.5~5 g		5~7.5 g		7.5~10 g		10~12.5 g		12.5~15 g		15~17.5 g		17.5~20 g		over 20 g
rates	5%	ov.	5%	ov.	5%	ov.	5%	ov.	5%	ov.	5%	ov.	5%	ov.	5%	ov.	5%
change	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
rise cases	1	5	6	11	17	14	9	6	5	4	3	1	0	0	0	0	0
fall cases	0	0	3	2	6	1	5	2	5	5	4	8	4	4	4	3	9
unchanged cases	2		24		25		23		7		10		1		3		0

Table 5 Hb Values in the Sixth Post Partum Week (collective case)
(unchanged.....± changes less than 5%)

blood loss (g./kg)	0~5 g		5~7.5 g		7.5~10 g		10~15 g		15~20 g		over 20 g	
rates	5%~	over	5%~	over	5%~	over	5%~	over	5%~	over	5%~	over
changes	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
rise cases	5	13	5	14	5	6	4	11	5	1	1	0
fall cases	1	4	1	1	4	3	5	5	2	1	1	3
unchanged cases	7		7		5		8		3		4	

trical operation had been performed, there were 115 primipara and 130 multipara to the total of 245 cases. Making careful observations of the changes of blood picture in puerperium, these selected 245 cases were studied and comparison was made according to the amounts of blood loss during delivery.

1) Collective results.

Collective results of the 245 subjects are shown in Tables 3, 4 and 5. When the Hb values at delivery, (1) immediately after delivery, and (2) on the 6th post partum day are studied stochastically, the groups being classified according to blood loss, the results are as follows :

In case of blood loss of less than 2.5 g./kg.

(1) $t_s=2.08 : t_s < t$ not significant

(2) $t_k=4.468 : t_s > t$ significant

in case of 2.5—5.0 g./kg. (1) $t_s = 0.807 : t_s < t$ not significant

(2) $t_s = 4.560 : t_s > t$ significant

in 5.0—7.5 g.

(1) $t_s = 1.984 : t_k < t$ not significant

(2) $t_k = 4.897 : t_k > t$ significant

in 7.5—10 g./kg.

(1) $t_s = 3.523 : t_s > t$ significant

(2) $t_s = 2.542 : t_s > t$ significant

in 10—12.5 g./kg.	(1)	$t_s = 3.828 : t_n > t$	significant
	(2)	$t_n = 0.367 : t_s > t$	not significant
in 12.5—15 g./kg.	(1)	$t_s = 4.687 : t_s > t$	significant
	(2)	$t_n = 2.763 : t_s > t$	significant
in 15—17.5 g./kg.	(1)	$t_s = 3.767 : t_s > t$	significant
	(2)	$t_s = 3.985 : t_s > t$	significant
in 17.5—20 g./kg.	(1)	$t_n = 3.104 : t_n > t$	significant
	(2)	$t_n = 3.951 : t_n > t$	significant
over 20 g./kg.	(1)	$t_s = 5.808 : t_s > t$	significant
	(2)	$t_s = 6.891 : t_s > t$	significant

When the Hb values at delivery and in the 6th post partum week are studied stochastically, the results are as follows :

In the case of blood loss :

less than 5 g./kg.	$t_s = 4.220 : t_s > t$	significant
5—7.5 g./kg.	$t_s = 4.658 : t_n > t$	significant
7.5—10 g./kg.	$t_s = 2.049 : t_s > t$	significant
10—15 g./kg.	$t_n = 1.897 : t_n > t$	not significant
15—20 g./kg.	$t_s = 1.485 : t_s > t$	not significant
over 20 g./kg.	$t_s = 2.460 : t_s > t$	significant

The greatest blood loss of the selected cases was 28.0 g./kg. (1,542 g.); and fluctuations of the Hb value in puerperium, expressed in percentage loss taking the Hb value at delivery as the basis are — 7.8 per cent immediately after delivery, — 31.4 per cent on the 6th post partum day, and — 4.8 per cent in the sixth post partum week.

1) Fluctuations of the hemoglobin concentration (Hb) immediately after delivery : In the group whose blood loss during delivery is less than 2.5 g./kg., though the Hb value rises slightly immediately after delivery, no significant change can be recognized. In the groups of over 2.5 g./kg., the rate of decrease in the Hb value tended to increase along with the increase in the amount of blood loss, and in the group with blood loss over 7.5 g./kg., a marked fall was recognized but even in the group with blood loss of over 20 g./kg. no marked anemia could yet be observed two hours after expulsion of the placenta.

2) Changes in the hemoglobin concentration on the sixth post Partum day : Changes in the hemoglobin concentration on the sixth post partum day present quite marked individual differences as shown in Table 4, and there was a tendency of an increasing number of cases showing a fall in the Hb value in proportion to the increase in blood loss. In the cases whose blood loss during delivery is less than 2.5 g./kg., the Hb on the 6th post partum day show 10.76 per cent increase as compared with that at delivery ; and this percentage of increase gradually falls along with increase in the amounts of the blood loss, and in the cases of the blood

loss up to 10 g./kg. a significant increase is observed in that the Hb value exceeds that at delivery but not quite up to that of normal non-pregnant women. In the cases of loss of 10 — 12.5 g./kg., Hb has recovered almost to the level at delivery and in the group of blood loss of more than 12.5 g./kg. the Hb value compared with that at delivery is significantly decreased and shows a marked delay in recovery.

3) Changes in Hb value in the sixth post partum week : As shown in Table 5, Hb in the sixth post partum week shows considerable individual differences, but compared with the Hb on the sixth post partum day it shows still more marked recovery. In the group of blood loss below 5 g./kg. Hb as compared with that at delivery shows about 9.1 per cent increase but as the amount of blood increases, there is seen a tendency of prolonging the delay in the rate of recovery. In the group of blood loss under 10 g./kg. Hb is almost up to the level of normal non-pregnant women but in the group of 10 — 20 g./kg. a slight increase in Hb as compared at delivery but no significant difference can be seen. In the group of over 20 g./kg. the recovery of Hb is still further delayed and show a significant fall. Namely, the Hb in the group of blood loss over 10 g./kg. as compared with that in the group of blood loss under 10 g./kg., there is a striking delay in the recovery of the Hb value in the sixth post partum week.

4) Comparison of recovery rates of erythrocyte counts and hemoglobin concentration (Hb) : As shown in Table 6 in the group whose blood loss ranges 5 — 20 g./kg. almost no difference in the falling rates of both erythrocyte count and Hb value can be discerned and both decrease in direct proportion to each other, but in the group of blood loss less than 5 g./kg. Hb value rather increases while on the other hand the erythrocyte count is found to have decreased ; and in the group of over 20 g./kg. the decrease in Hb is quite marked as compared with that of erythrocyte count. On the sixth post partum day in the group whose blood loss is below 15 g./kg. no marked difference can be observed in the rates of recovery between Hb and erythrocyte count, while in the group with more than 15 g./kg. loss, the recovery of Hb is more delayed as compared with that of erythrocyte count. In the sixth post partum week even in cases whose blood loss is small, the recovery of erythrocyte count as compared with that of Hb is extremely more rapid, and this tendency becomes still more marked as the amount of blood loss grows larger. Occasionally in the group with blood loss over 15 g./kg. the Hb value is found strikingly delayed. When changes in Rote (erythrocyte count) and Hb for the period ranging from the delivery to the sixth post partum day are compared

Table 6 Blood Picture up to the Sixth Post Partum Week

blood loss (g./kg)	0~5 g (19 cases)			5~10 g (31 cases)			10~15 g (16 cases)		
	E (10,000)	Hb(%)	FI	E (10,000)	Hb(%)	FI	E (10,000)	Hb(%)	FI
at deliv.	450.6	83.0	0.93	413.7	80.5	0.97	405.0	78.8	0.98
immed. after deliv.	428.7 (-4.07)	83.7 (+0.85)	0.97	401.4 (-2.97)	79.7 (-3.30)	0.97	378.5 (-5.73)	75.2 (-4.63)	0.99
sixth p. p. day	468.8 (+4.07)	87.6 (+5.36)	0.93	415.1 (+0.43)	82.0 (+1.99)	0.99	390.0 (-4.43)	75.2 (-4.36)	0.97
sixth p. p. week	502.7 (+12.87)	87.6 (+6.29)	0.88	473.8 (+14.40)	87.3 (+8.93)	0.93	432.1 (+6.91)	80.5 (+2.57)	0.92

() increase or decrease rate

15~20 g (6 cases)			over 20 g		
E (10,000)	Hb(%)	FI	E (10,000)	Hb(%)	FI
405.3	77.4	0.96	433.4	84.3	0.98
390.0 (-3.40)	74.1 (-4.20)	0.96	416.1 (-2.72)	76.0 (-8.66)	0.92
411.6 (-1.46)	72.5 (-6.01)	0.93	353.0 (-15.93)	66.7 (-20.72)	0.95
438.1 (+9.55)	79.0 (+2.05)	0.90	423.7 (-2.81)	74.5 (-12.15)	0.88

with the amounts of blood loss, in the group of blood loss of less than 10 g./kg. only a slight fall both in Rote and Hb on the first post partum day, and the recovery thereafter is markedly rapid and blood loss hardly affects the recovery. In the group with blood loss of more than 10 g./kg. a marked fall both in Rote and Hb is recognized during the first to third post partum days, though increasing gradually afterward both Rote and Hb on the sixth post partum day do not recover to the level at delivery, and with increase of blood loss there is a tendency of delay in recovery of both. Especially in the group with blood loss over 15 g./kg. the fall in Rote and Hb is quite pronounced at the early stage of puerperium (the third post partum day), and moreover, the rates of recovery are also

Table 7 Blood Picture in the Early Stage of Puerperium

blood loss (g./kg.)	case		pre- preg.	immed. after deliv.	1st p. p. day	3rd p. p. day	5th p. p. day	6th p. p. day
0~5 g	17	erythrocytes (10,000)	456.1	431.2	426.6	433.8	450.0	466.7
		Hb (%)	81.6	83.0	80.9	81.6	84.1	86.8
5~10 g	27	erythrocytes (10,000)	414.3	405.5	398.2	403.2	415.0	422.3
		Hb (%)	81.3	77.7	79.6	80.0	81.6	82.5
10~15 g	14	erythrocytes (10,000)	414.6	394.1	366.8	384.5	392.7	412.4
		Hb (%)	80.3	76.8	75.1	75.1	76.2	78.7
15~20 g	7	erythrocytes (10,000)	429.7	402.4	382.4	355.5	369.1	390.1
		Hb (%)	81.2	75.8	70.0	67.6	71.4	72.0
over 20 g	5	erythrocytes (10,000)	454.0	425.0	376.4	353.8	358.0	365.6
		Hb (%)	85.7	79.1	70.7	68.1	69.6	67.8

markedly delayed.

5) Relationship between hemoglobin index and amount of blood loss : Although no change in the hemoglobin index can be seen up to the sixth post partum day, in the sixth post partum week the hemoglobin index compared with those at delivery and on the sixth post partum day shows a fall irrespective of amounts of blood loss. Namely, in the sixth post partum week the recovery of Hb as compared with erythrocyte count is not sufficient.

2. SEPARATE STUDIES ON PRIMIPARA AND MULTIPARA

Dividing the 245 subjects in two groups of primipara and multipara, changes in Hb during puerperium are classified into groups according to blood loss and are presented in Tables 8 and 9, and their curves in Figs. 3 and 4.

A) *Multipara* : When Hb at delivery in the group with blood loss less than 5 g./kg. and the same in the respective groups in Table 8 are stochastically studied, neither one shows any significant difference.

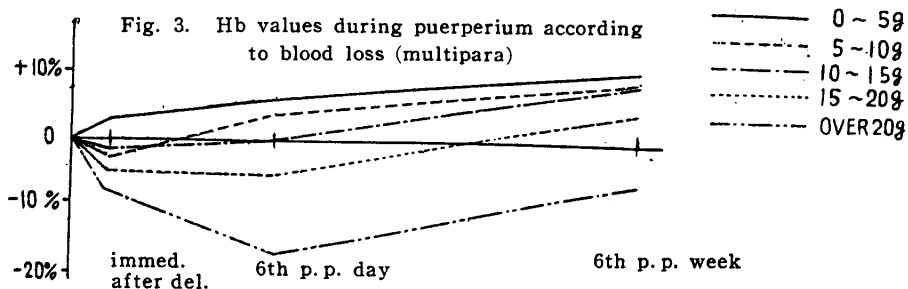
Next, comparing stochastically Hb at delivery with those at ① immediately after delivery, ② on the sixth post partum day, and ③ in the sixth post partum week according to respective blood-loss group, and studying stochastically Hb values immediately after delivery, on the sixth post partum day, and in the sixth post partum week shown by the group

Table 8 Multipara Hb Values during Puerperium According to Blood Loss

up to the 6th p.p. day							
blood loss (g./kg.)	0~5 g	5~7.5	7.5~10	10~12.5	12.5~15	15~20	over 20 g
cases	30	30	24	14	15	12	5
at deliv.	80.0 ±3.72	79.4 ±3.10	76.1 ±3.40	80.2 ±4.38	78.9 ±3.90	81.5 ±6.11	78.5 ±4.29
immed. after deliv.	80.8 ±5.58 (+0.94)	76.5 ±3.10 (-3.41)	73.6 ±3.44 (-3.01)	78.5 ±3.99 (-1.85)	76.0 ±4.29 (-3.78)	75.4 ±6.33 (-7.20)	73.0 ±3.82 (-6.94)
6th p.p. day	83.8 ±4.69 (+4.97)	84.6 ±3.33 (+6.78)	78.8 ±4.28 (+3.59)	85.7 ±5.77 (+6.47)	78.8 ±4.67 (-0.07)	74.6 ±5.79 (-7.20)	65.6 ±3.62 (-16.3)
6th p.p. week							

p.p. = post partum ± reliability limit () increase or decrease rate

up to the 6th p.p. week				
0~5 g	5~10	10~15	15~20	over 20 g
14	19	15	8	4
81.2 ±7.12	74.1 ±38.4	78.8 ±4.56	80.7 ±9.29	81.2 ±17.64
83.6 (+2.93)	72.0 (-2.65)	77.5 (-1.41)	76.7 (-4.31)	75.0 (-7.57)
84.5 (+5.75)	76.6 (+3.94)	79.0 (+0.23)	74.9 (-5.41)	67.2 (-17.07)
88.2 ±4.50 (+10.57)	81.0 ±5.61 (+9.51)	84.9 ±4.62 (+9.25)	85.1 ±10.12 (+5.50)	75.7 ±19.23 (-6.45)



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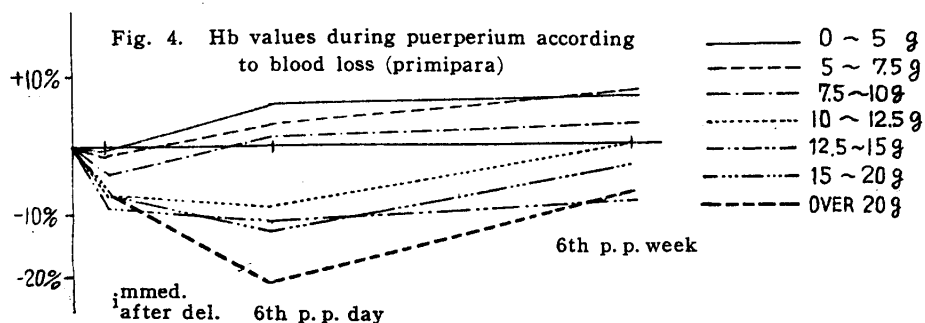
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Table 9 Primipara Hb Values during Puerperium According to Blood Loss

up to the 6th p.p. day							
blood loss (g./kg.)	0~5 g	5~7.5	7.5~10	10~12.5	12.5~15	15~20	over 20 g
cases	24	33	21	12	11	7	7
at deliv.	84.5	85.7	84.0	83.8	88.1	86.6	85.5
	± 4.10	± 3.53	± 1.53	± 6.99	± 7.49	± 7.36	± 9.75
immed. after deliv.	83.0	85.0	80.4	77.2	81.1	80.5	78.7
	± 3.97	± 3.39	± 3.64	± 7.49	± 8.19	± 6.80	± 11.40
	(-1.34)	(-0.60)	(-4.14)	(-8.03)	(-8.06)	(-6.9)	(-8.05)
6th p.p. day	89.4	87.7	85.0	75.9	77.8	75.4	69.9
	± 4.42	± 3.08	± 1.21	± 5.67	± 8.37	± 6.53	± 10.58
	(+6.23)	(+2.64)	(+1.64)	(-9.14)	(-11.94)	(-12.7)	(-18.0)
6th p.p. week							

\pm reliability limit () increase or decrease rate

up to the 6th p.p. week						
0~5 g	5~7.5	7.5~10	10~12.5	12.5~15	15~20	over 20 g
16	21	11	10	8	4	5
83.8	84.4	84.0	83.9	83.6	81.3	90.5
± 5.08	± 3.96	± 4.28	± 5.37	± 8.88	± 8.10	± 3.04
83.2	83.2	79.8	77.6	75.8	76.0	84.5
(-0.46)	(-1.07)	(-4.74)	(-7.6)	(-9.2)	(-6.55)	(-6.62)
88.9	86.6	84.6	75.7	73.6	70.7	72.2
(+6.44)	(+3.15)	(+1.17)	(-9.3)	(-12.1)	(-12.82)	(-20.42)
89.8	91.4	85.9	83.9	76.2	78.7	83.5
± 6.20	± 5.22	± 4.78	± 9.44	± 11.20	± 10.01	± 1.61
(+7.80)	(+8.22)	(+3.1)	(+0.14)	(-8.78)	(-3.05)	(-7.24)



with blood loss less than 5 g./kg. and those values at the corresponding periods shown by the groups with blood loss over 5 g./kg., the results are as follows:

- 1) Results immediately after delivery and on the sixth post partum day:
 - (1) in the group less than 5 g./kg.
 - ① $t_s=0.717: t_s < t$ not significant
 - ② $t_s=2.541: t_s > t$ significant
 - (2) in 5—7.5 g./kg.
 - ① $t_s=2.795: t_s < t$ significant
 - ② $t_s=4.718: t_s > t$ significant
 - in between
under 5 g./kg. (control) and 5—7.5 g./kg.
 - a) immediately after delivery
 $t_s=1.79: t_s < t$ not significant
 - b) on the sixth post partum day
 $t_s=0.07: t_s < t$ not significant
 - (3) in 7.5—10 g./kg.
 - ① $t_s=2.498: t_s > t$ significant
 - ② $t_s=2.756: t_s > t$ significant
 - in between
under 5 g./kg. (control) and 7.5—10 g./kg.
 - (a) immediately after delivery
 $t_s=2.04, R=2.24$ significant
 - (b) on the sixth post partum day
 $t_s=1.58: t_s < t$ not significant
 - (4) in 10—12.5 g./kg.
 - ① $t_s=1.231: t_s < t$ not significant
 - ② $t_s=2.386: t_s > t$ significant
 - in between
under 5 g./kg. (control) and 10—12.5 g./kg.
 - (a) immediately after delivery
 $t_s=0.74: t_s < t$ not significant
 - (b) on the sixth post partum day
 $t_s=0.50: t_s < t$ not significant
 - (5) in 12.5—15 g./kg.
 - ① $t_s=2.710: t_s > t$ significant
 - ② $t_s=0.038: t_s < t$ not significant
 - in between
under 5 g./kg. (control) and 12.5—15 g./kg.
 - a) immediately after delivery
 $t_s=1.54: t_s < t$ not significant
 - b) on the sixth post partum day
 $t_s=1.40: t_s < t$ not significant
 - (6) in 15—20 g./kg.
 - ① $t_s=1.877: t_s < t$ not significant
 - ② $t_s=3.58: t_s > t$ significant
 - in between
under 5 g./kg. (control) and 15—20 g./kg.
 - a) immediately after delivery
 $t_s=1.73: t_s < t$ not significant
 - b) on the sixth post partum day
 $t_s=2.20: t_s > t$ significant

- (7) over 20 g./kg. ① $t_n=7.12: t_n>t$ significant
② $t_s=5.480: t_s>t$ significant
in between under 5 g./kg. (control) and above 20 g./kg.
(a) immediately after delivery
 $t_n=1.50: t_s>t$ not significant
(b) on the sixth post partum day
 $t_s=2.05: t_n>t$ significant
- 2) Observations in the sixth post partum week
- (1) under 5 g./kg. ③ $t_n=3.39: t_s>t$ significant
(2) 5—10 g./kg. ③ $t_s=2.920: t_s>t$ significant
in between
under 5 g./kg. (control) and 5—10 g./kg.
 $t_s=2.14$ $R=1.85$ not significant
- (3) 10—15 g./kg. ③ $t_s=3.6.43: t_s>t$ significant
in between
under 5 g./kg. (control) and 10—15 g./kg.
 $t_s=1.08: t_s<t$ not significant
- (4) 15—20 g./kg. ③ $t_s=2.411: t_s>t$ significant
inbetween
under 5 g./kg. (control) and 15—20 g./kg.
 $t_s=0.72: t_s<t$ not significant
- (5) over 20 g./kg. ③ $t_s=1.373: t_s<t$ not significant
in between
below 5 g./kg. (control) and above 20 g./kg.
 $t_s=2.54: t_s>t$ significant

As is clear from the above Hb on the sixth post partum day in multipara of the groups with blood loss 12.5 g./kg. shows a significant increase as compared with Hb at delivery but in the groups with blood loss of above 15 g./kg., Hb compared with that at delivery shows a significant fall and the delay in recovery of Hb can be recognized. In all the groups with blood loss less than 20 g./kg. Hb in the sixth post partum week presents a significant increase as compared with Hb at delivery, and it has recovered practically to the level of control group; however, in the group with blood loss of over 20 g./kg. the delay in recovery of Hb value can be seen. Moreover, in comparing with the group with as small blood loss as under 5 g./kg. Hb values showed a significant fall only in the group with blood loss of more than 15 g./kg. on the sixth post partum day and in the group with over 20 g./kg. loss in the sixth post partum week.

B) *Primipara*: When Hb values at delivery in the group with blood loss under 5 g./kg. as shown in Table 9 and those of various groups were studied stochastically, no significant difference could be observed in any group.

Next, Hb values at delivery were compared stochastically with Hb values ① immediately after delivery, ② on the sixth post partum day, and ③ in the sixth post partum week according to the bloodloss classifications; and in addition Hb values immediately after delivery, on the sixth post partum day, and in the sixth post partum week shown by the group under 5 g./kg. loss and Hb of group with more than 5 g./kg. loss at the corresponding periods were studied stochastically; and the results are as follows:

- 1) Those immediately after delivery and on the sixth post partum day.
 - (1) group under 5 g./kg.
 - ① $t_s=0.654: t_s < t$ not significant
 - ② $t_s=3.712: t_s > t$ significant
 - (2) 5—7.5 g./kg.
 - ① $t_s=0.405: t_s < t$ not significant
 - ② $t_s=2.297: t_s > t$ significant

in between
under 5 g./kg. (control) and 5—7.5 g./kg.

 - a) immediately after delivery
 $t_s=0.73: t_s < t$ not significant
 - b) on the sixth post partum day
 $t_s=2.021: t_s < t$ not significant
- (3) 7.5—10 g./kg.
 - ① $t_s=2.469: t_s > t$ significant
 - ② $t_s=0.962: t_s > t$ not significant

in between
under 5 g./kg. (control) and 7.5—10 g./kg.

 - a) immediately after delivery
 $t_s=0.99: t_s < t$ not significant
 - b) on the sixth post partum day
 $t_s=2.05$ $R=1.92$ not significant
- (4) in the group of 10—12.5 g./kg.
 - ① $t_s=4.145: t_s > t$ significant
 - ② $t_s=4.655: t_s > t$ significant

in between
5 g./kg. (control) and 10—12.5 g./kg.

 - a) immediately after delivery
 $t_s=1.56: t_s < t$ not significant
 - b) on the sixth post partum day
 $t_s=3.73: t_s > t$ significant
- (5) 12.5—15 g./kg.
 - ① $t_s=4.228: t_s > t$ significant
 - ② $t_s=5.082: t_s > t$ significant

in between
under 5 g./kg. (control) and 12.5—15 g./kg.

 - a) immediately after delivery
 $t_s=0.46: t_s < t$ not significant
 - b) on the sixth post partum day
 $t_s=2.78: t_s > t$ significant
- (6) 15—20 g./kg.
 - ① $t_s=6.916: t_s > t$ significant
 - ② $t_s=4.901: t_s > t$ significant

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- in between
under 5 g./kg. (control) and 15–20 g./kg.
- a) immediately after delivery
 $t_s = 0.62: t_s < t$ not significant
 - b) on the sixth post partum day
 $t_s = 3.30: t_s > t$ significant
- (7) above 20 g./kg.
- ① $t_s = 5.180: t_s > t$ significant
 - ② $t_s = 14.515: t_s > t$ significant
- in between
under 5 g./kg. (control) and over 20 g./kg.
- a) immediately after delivery
 $t_s = 0.99: t_s < t$ not significant
 - b) on the sixth post partum day
 $t_s = 4.26: t_s > t$ significant
- 2) Observations in the sixth post partum week
- (1) under 5 g./kg. ③ $t_s = 2.274: t_s > t$ significant
 - (2) 5–7.5 g./kg. ③ $t_s = 4.420: t_s > t$ significant
- in between
under 5 g./kg. (control) and 5–7.5 g./kg.
- $t_s = 0.41: t_s > t$ not significant
- (3) 7.5–10 g./kg. ③ $t_s = 0.738: t_s < t$ not significant
- in between
under 5 g./kg. (control) and 7.5–10 g./kg.
- $t_s = 0.99: t_s < t$ not significant
- (4) 10–12.5 g./kg. ③ $t_s = 0.108: t_s < t$ not significant
- in between
under 5 g./kg. (control) and 10–15 g./g.
- $t_s = 2.51: t_s > t$ significant
- (5) 12.5–15 g./kg. ③ $t_s = 2.265: t_s > t$ significant
 - (6) 15–20 g./kg. ③ $t_s = 0.717: t_s > t$ not significant
- in between
under 5 g./kg. (control) and 15–20 g./kg.
- $t_s = 2.11: t_s > t$ significant
- (7) over 20 g./kg. ③ $t_s = 1.882: t_s < t$ not significant
- in between
under 5 g./kg. (control) and over 20 g./kg.
- $t_s = 1.16: t_s < t$ not significant

As is evident from the above, on the sixth post partum day each group of primipara with blood loss up to 7.5 g./kg. shows significant increase in the hemoglobin concentration (Hb) as compared with Hb at delivery while the groups with more than 10 g./kg. loss show a significant decrease in Hb as compared with that at delivery, indicating the delay in recovery of Hb values.

In the sixth post partum week every one of groups with blood loss under 7.5 g./kg. shows a significant increase in Hb as compared to that at

delivery, which has returned to the level of the control, while in each of those with blood loss of over 10 g./kg., Hb at this stage has fallen as compared with that at delivery and the delay in recovery of Hb can be recognized. Both on the sixth post partum day and in the sixth post partum week in every group with blood loss of more than 10 g./kg. as compared to that of the group with a small blood loss of under 5 g./kg. presents a significant fall in Hb.

3. RELATIONSHIP BETWEEN CHANGES OF Hb IN PUERPERIUM AND FREQUENCIES OF LABOR.

Of the 84 multipara with blood loss under 10 g./kg. at delivery when they are studied according to the frequency of labor, namely, group who had one labor, those 2—3 times, and those more than 4 times, as shown in Table 10, on the sixth post partum day the group with one labor show +3.64 per cent increase of Hb, those of 2—3 times +7.12 per cent increase, and those over 4 times +9.5 per cent increase; and every one of the groups shows a significant increase when Hb at this stage is compared stochastically with that at delivery. On the sixth post partum week the group with one labor show +6.73 per cent increase of Hb, those of 2—3 times +16.8 per cent increase; and every one of the groups shows a significant increase when Hb at this stage is compared stochastically with that at delivery. As is evident from these data, the rate of increase in Hb value has a tendency to become greater along with increase in the frequency of labor.

Table 10 Relationship Between Hb in Puerperium and Frequencies of Labor

freq.	1×	2×~3×	over 4×	1×	2×~3×	over 4×
cases	55	22	7	23	10	0
at deliv.	79.9	76.2	77.0	79.0	72.8	
immed. after deliv.	77.2 (-2.71)	75.3 (-0.29)	77.5 (+0.84)	78.3 (-0.88)	73.9 (+1.59)	
6th p. p. day	83.0 (+3.64)	81.4 (+7.12)	83.9 (+9.5)	81.3 (+3.02)	78.2 (+7.81)	
6th p. p. week				83.8 (+6.73)	84.7 (+16.8)	

() increase or decrease rate

3. SUMMARY AND DISCUSSION

SUZUKI¹⁵, TATÉ¹⁹, WAKABASHI²¹ NOSE¹², OGAWA¹⁴, TSUTSUI¹⁸, KAWAKAMI⁸ and VEIT⁴⁶ report that in post partum hemorrhage erythrocyte counts, Hb values and Ht (hematocrit values) decrease in proportion to the amounts of blood loss with lapse of time after the hemorrhage; and on the second-third post partum day they become extremely anemic as compared with those with normal blood loss; and though recovering by degrees, there is a marked delay in recovery as compared with normal puerperium. Concerning the recovery of blood picture in puerperium in the cases of postpartum hemorrhage DIECKMANN et al.²⁸ report that with 1,020 c. c. of blood loss during delivery Hb returns to normal in the eighty postpartum week; CRAWFORD²⁷ claims that with blood loss of 500—600 c.c. it does not yet return to normal by the tenth post partum day; TSUTSUI¹⁸ mentions that in case of a great quantity of blood loss during delivery the recovery requires one month to one and a half months; TANAKA¹⁷ says that with blood loss to the amount of 600—700 c.c. during delivery Hb on the tenth post partum day shows a fifteen per cent decrease as compared with that at delivery; KAWAKAMI⁸ reports that in case of postpartum hemorrhage the decreases in erythrocyte counts and Hb values are marked and anemia is still pronounced even on the tenth post partum day; STOECHKE⁴¹ u. EDWARD⁴¹ say that with blood loss over 800 c.c. during delivery Hb does not reach to that immediately after delivery even on the seventh postpartum day; OGAWA¹⁴ mentions that in the cases with blood loss of 700—1,050 c.c. during delivery Hb values decrease gradually up to the end of the first postpartum week or to the end of the second week, showing no spontaneous recovery and that in every case there is a marked delay in recovery of erythrocyte counts and Hb; while POHL u. BERGMANN³⁹ mention that they recognized a rapid recovery. Concerning the influences of blood loss during puerperium brought upon blood picture during puerperium as can be judged from the above there is no report giving the results of comprehensive studies made in detail according to the amounts of blood loss during delivery. Furthermore, scanning the reports by various investigators even with regards the delay in recovery there is not any result in perfect agreement with one another. This discrepancy seems to be due to the fact that no prolonged observations are carried out during puerperium and also due to considerably great individual differences caused by equally great differences in the rates of recovery of blood picture during puerperium, which are under influences of various factors such as existence or non-existence of edema in the mother's

body before delivery, amounts of blood loss during delivery, lochia rubra, lactation, recovery of genital organ, hematopoietic functions, and water metabolism. Moreover, since criterion of recovery of anemia varies according to each investigator for example, various Hb values such as that of nonpregnant woman, early stage of pregnancy, the latter part of pregnancy, at delivery, or immediately after delivery, is taken as criterion; thus the determination of the rates of recovery seems to vary according to different investigator.

The author used the Hb values at delivery as criterion in all his studies because by continuous examinations through pregnancy, delivery, and puerperium as described in early part he noticed that the Hb values at delivery both in primipara and multipara presented a significant decrease as compared with Hb of healthy non-pregnant women and gave about seven per cent rate of decrease; and the author also made comparative studies on the changes of Hb values during puerperium, using Hb of healthy non-pregnant women as the basis of comparison. In the present studies in the group with blood loss as small as under 2.5 g./kg., Hb values immediately after delivery as compared with that at delivery rose slightly but erythrocyte counts decreased a little. This is assumed, as reported by IZUMIDANI⁴ and BARCROFT²⁵, to be due to the outflow of erythrocytes rich in hemoglobin from various viscera such as spleen, into circulating blood. In the groups with blood loss of more than 2.5 g./kg., as reported by SUZUKI¹⁵, TATÉ¹⁰, ISHIKAWA³, NAKANISHI¹³, YASUI²³, NAKAYAMA¹¹, SUHO¹⁶, SCHRÖDER⁴³ and DIETRICH²⁹, Hb values gradually increase along with increase in the amounts of blood loss; and especially in the groups with over 7.5 g./kg. blood loss Hb as compared with that before delivery shows a significant fall; but as SUZUKI¹⁵ reported, even two hours after delivery no anemia of high degree appeared despite a great loss of blood. Namely, even in the cases with a great loss of blood no marked anemia could be discerned two hours after the expulsion of placenta; and erythrocyte counts and Hb values, gradually decreasing thereafter, on the third post partum day reached to the lowest level, presenting a marked anemia, but later they started to recover.

On the sixth post partum day Hb values in the majority cases with blood loss under 2.5 g./kg. were identical with those of healthy non-pregnant women; in the groups with the loss of 2.5—10 g./kg. Hb exceeded those at delivery; in the cases with 10—12.5 g./kg. loss Hb values returned more or less to those at delivery; in the groups with more than 12.5 g./kg. loss the delay in recovery of Hb and a marked decrease in the values as compared with those at delivery could be recognized. Hb values

in the sixth post partum week in the group with below 10 g./kg. loss returned close to those of healthy non-pregnant women; and in the Hb in the groups of 10—20 g./kg. the delay in recovery could be recognized but the values themselves were found to have returned almost back to those at delivery; and in the groups with over 20 g./kg. loss Hb compared with those at delivery showed a significant decrease and the recovery of Hb presented a marked delay. In other words, in the groups with blood loss under 10 g./kg., the rates of recovery of Hb during puerperium is markedly rapid, and hematopoietic functions of the mother's body seem to have not at all been disturbed; and in the groups with 10—12.5g./kg. loss the rate of recovery is rather slow; and in the groups with blood loss of over 12.5g./kg. the recovery of Hb is markedly hindered and the hematopoietic functions of the mother's body seem to have been greatly disturbed; and in the groups with blood loss of over 20 g./kg. these disturbances are particularly marked. Again, in the cases with normal blood loss DIECKMANN²⁸ reports that Hb in the second postpartum week is 17 per cent below the normal value and in the eighth postpartum week Hb is 14 per cent below the normal; while KÜHNEI³⁴ states Hb on the 5th—8th days is 10—15 per cent below the normal; while in the present studies Hb returned to the normal level on the 6th postpartum day in the groups with blood loss below 7.5 g./kg. and showed a markedly rapid recovery.

Concerning hemoglobin index in the cases with postpartum hemorrhage, KAWAKAMI⁸ states that no marked difference could be recognized on the 10th postpartum day; OGAWA¹⁴, WAKABAYASHI²¹, TSUTSUI¹⁸, NAKAYAMA¹¹, STOECKEL⁴¹, DIETRICH²⁹ and KÜHNEL³⁴ report that in the cases of postpartum hemorrhage similar to the cases with a small loss of blood at delivery the recovery of erythrocyte counts is more rapid than that of Hb, and a fall in the hemoglobin index is noticed. In the present study likewise in the early stage of puerperium no marked change could be observed in the hemoglobin index as reported by various investigators, and in the 6th postpartum week a marked fall in the hemoglobin index was observed in the cases both with a great loss of blood as well as a small loss. Relative to the complete recovery of hemoglobin index, KÜHNEL³⁴ reports that it requires six month from delivery and it seems that the recovery requires a considerable length of time.

Comparing the rates of recovery of Hb values during puerperium dividing into primipara and multipara groups, both groups like those collective cases show a delay in the Hb values in puerperium in a proportionate degree to the increase in blood loss. On the sixth postpartum day in multipara with over 15 g./kg. loss and in primipara with over 10 g./kg

loss, and in the sixth postpartum week multipara groups with blood loss over 20 g./kg. and in primipara with over 10 g./kg. respectively, showed a significant difference as well as a marked delay in the recovery of Hb compared with that of groups with a small blood loss of under 5 g./kg.

Again, when the Hb values at delivery are taken as a criterion, on the sixth postpartum day in multipara groups with blood loss of up to 12.5 g./kg., and in primipara with blood loss up to 7.5 g./kg. in the sixth post partum week in multipara with blood loss up to 20 g./kg., and primipara with the loss up to 7.5 g./kg., Hb values of each respective group showed a significant difference as compared with the values at delivery.

From these rates of recovery of Hb during puerperium, Hb values during puerperium recovered smoothly in the multipara with blood loss of below 12.5 g./kg., and in the primipara groups with blood loss under 7.5 g./kg. at delivery, but there was a tendency of delay in the recovery of Hb in the multipara with blood loss of over 15 g./kg. as well as in the primipara with the loss over 10 g./kg. In addition it was found that the greater the number of labor the greater is the rate of Hb increase. SUZUKI¹⁶ states that in non-pregnant multipara the majority have a greater quantity of plasma and their blood is in a more diluted state than that in virgins; TANAKA¹⁷ says that multipara show a greater degree of hydremia than primipara; and KERWIN and COLLINS³³ claim that the Hb values of multipara are lower than those of primipara. As has already been clarified in the present studies, the reason of a more rapid recovery of Hb during puerperium in multipara than in primipara lies in the fact, as reported by various investigators, that the degree of hydremia in multipara during the periods of pregnancy and delivery is greater than that of primipara thereby Hb values of multipara during puerperium seem to recover more rapidly than those of primipara. Moreover, it is thought that in multipara with increase in the number of labor puerperal involution is carried out more smoothly than that in primipara and for that reason the blood picture recovers more smoothly than primipara and for the groups with blood loss of over 7.5 g./kg. the Hb recovery in multipara is swifter than that in primipara.

CONCLUSIONS

For the periods ranging from the fifth gravid month to the sixth post partum week continuous examinations were conducted on the blood picture of 10 multiparas and 18 primipars who came to the Second Maternity Hospital, Okayama University Medical School, from December 1955 to December 1956, and all those who had no complications throughout preg-

nancy, delivery and puerperium.

In addition observations were carried on the 245 subjects who had no complication through pregnancy, delivery and puerperium to see what influences the blood loss during delivery might exert on blood picture during puerperium, particularly the changes of hemoglobin concentration (Hb), and the author arrived at the following conclusions :

1) By the continuous examinations of pregnant women the existence has been recognized of physiological anemia which recovers close to the level of healthy non-pregnant women within one month after delivery. Namely, it has been found that already by the fifth month of pregnancy a considerable decrease both in erythrocyte counts and Hb values is recognized as compared with those of healthy non-pregnant women (the control), but starting around the eighth month the values of both keep on increasing month after month until reaching their maximum at delivery yet still a little below those of the control, and particularly Hb values as compared with those of the control show a significant fall. During puerperium erythrocyte counts and Hb values recover rapidly and by the sixth post partum week they reach close to the level of the control.

2) By the latter part of pregnancy both in multipara and primipara Hb values shew a marked decrease as compared with erythrocyte count. Gradually presenting hypochromic-anemia picture, even in the sixth post partum week a delay in the recovery of Hb values can still be recognized, the delay being particularly striking in primipara.

3) It has been noticed that there is a greater tendency of delay in the recovery of Hb values along with increase in blood loss during delivery. Namely, though in the groups with blood loss of less than 10 g./kg. at delivery the recovery of Hb values during puerperium is smooth and hematopoietic functions seem to be undisturbed. However, with increase in blood loss the recovery is proportionately delayed and in the groups with over 12.5 g./kg. loss a marked delay in the recovery of Hb has been recognized.

4) In primipara groups with under 7.5 g./kg. blood loss and in multipara with under 12.5 g./kg. loss, the recovery of Hb values during puerperium is smooth; but in primipara with blood loss of over 10 g./kg. and in multipara with the loss of over 15 g./kg. the delay has been quite marked. In other words, in the groups with blood loss of over 7.5 g./kg. the rate of recovery in Hb values tends to be faster in multipara than in primipara.

5) Along with increase in the frequency of labor, the rates of increase have tended to increase by degrees.

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